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A
1 1. An electrochemical storage medium comprising a
2 carrier mixed with a reduced boron-containing compound, the
3 reduced compound being oxidizable to an oxidized boron-
4 containing compound concurrent with the generation of an
5 electric current, the storage medium being in electrical
6 contact with an electrode for carrying current generated
7 during that oxidation.

a
1 2. The storage medium of claim 1 in which the
2 reduced compound is a borohydride (BH_4)⁻.

1 3. The storage medium of claim 1 in which the
2 oxidized compound is a borate (BO_2)⁻.

1 4. The storage medium of claim 1 in which the
2 carrier is an aqueous solution.

1 5. The storage medium of claim 1 in which the
2 carrier is a non-aqueous solution.

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1 6. The storage medium of claim 5 in which the
2 carrier is a non-aqueous solution comprising a liquid that
3 dissolves the reduced compound.

1 7. The storage medium of claim 6 in which the
2 carrier is selected from the group consisting of: anhydrous
3 ammonia; amines; non-amine organic bases; alcohols; alkene
4 carbonates; and glycols.

1 8. The storage medium of claim 5 in which the
2 carrier is selected from the group consisting of:
3 dimethylformamide; dimethylsulfoxide; tripropylamine;
4 pyridine; quinoline; triethanolamine; monethanolamine;

5 ethylene glycol; propylene glycol; methanol; ethanol;
6 ethylene carbonate; and propylene carbonate.

1 ⁸
2 ~~2~~ The storage medium of claim ⁵~~5~~ in which the non-
3 aqueous solution comprises a solubilizer or a conductivity
4 enhancer.

1 ⁹
2 ~~10~~ The storage medium of claim ⁵~~6~~ in which the non-
3 aqueous solution comprises an agent selected from the group
4 consisting of EDTA, crown ethers, cryptates, and quaternary
5 ammonium salts.

1 ¹⁰
2 ~~11~~ The storage medium of claim ¹~~1~~ positioned to be
3 the anode of a battery.

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1 ~~12~~ A battery comprising an anode and a cathode in
2 electrical communication,
3 the anode comprising a carrier mixed with a
4 reduced boron-containing compound, the reduced compound
5 being oxidizable to an oxidized boron-containing compound
6 concurrent with the discharge of the battery.

a
1 ~~13~~ The battery of claim ~~12~~ in which the reduced
2 compound is a borohydride (BH_4)⁻.

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1 ¹²
2 ~~14~~ The battery of claim ¹¹~~12~~ or claim ~~13~~ in which
3 the oxidized compound is a borate (BO_2)⁻.

1 ¹³
2 ~~15~~ The battery claim ¹¹~~12~~ in which the carrier is a
3 solution.

1 ¹⁴
2 ~~16~~ The battery of claim ¹¹~~12~~ in which the carrier is
3 an aqueous mixture.

1 ¹⁵~~17~~. The battery of claim ¹¹~~12~~ in which the carrier is
2 a non-aqueous mixture.

1 ¹⁶~~18~~. The battery of claim ¹¹~~12~~ in which the cathode
2 comprises a catholyte which includes an oxidizing agent.

1 ¹⁷~~19~~. The battery of claim ¹⁶~~18~~, in which the oxidizing
2 agent is selected from: air; O₂; compounds comprising
3 oxygen and a halogen; and X₂, where X is a halogen.

1 ¹⁸~~20~~. The battery of claim ¹⁷~~19~~ in which the oxidizing
2 agent is perchlorate (ClO₄⁻), chlorate (ClO₃⁻), chlorite
3 (ClO₂⁻), hypochlorite (OCl⁻), chlorine (Cl₂), bromine (Br₂),
4 bromate (BrO₃⁻), or iodate (IO₃⁻).

1 ¹⁹~~21~~. The battery of claim ¹⁶~~18~~ in which the oxidizing
2 agent is a) [MnO₄]⁻; b) [FeO₄]⁻²; c) CeOH(NO₃)₃; d)
3 [Ce(NO₃)₆]⁻²; e) [Fe(CN)₄]⁻³; f) [CrO₄]⁻²; g) [SnO₃]⁻²; h)
4 [BiO₃]⁻; i) MnO₂; j) Ag₂O; k) AgO; l) CeO₂; m) PbO₂; n)
5 NiO(OH); o) NiO₂; p) CoO(OH); q) [NO₃]⁻; r) [NO₂]⁻; s)
6 [S₂O₈]⁻²; t) compounds containing Cu(III), Tl(III), Hg (II),
7 Se (VI), or Te(VI); or u) R(NO₂)_n where R is an alkyl, aryl,
8 or arylakyl organic group and n = 1-6.

1 ²⁰~~22~~. The battery of claim ¹⁶~~18~~ in which the oxidizing
2 agent is trinitrobenzoic acid, hexanitrobenzene, or
3 trinitrobenzene.

21
23. A battery as in claim 11 in which the anode
comprises an anolyte, the cathode comprises a catholyte, and
the anolyte and catholyte are separated by a permiselective
membrane.

22
24. A battery as in claim 21 in which the membrane
is an anionic membrane.

23
25. A battery as in claim 21 where the membrane is
a cationic membrane.

24
26. A battery as in claim 21 where the membrane is
bipolar.

25
27. A battery as in claim 11 or claim 13 where the
cathode is an air breathing cathode.

26
28. A battery as in claim 11 which comprises a
catholyte which can be oxidized by air to produce an agent
that then oxidizes borohydride to borate with the generation
of electrical current.

27
29. A battery as in claim 26 wherein the catholyte
is reoxidized by air in a cycle after it has generated
electricity by oxidizing the borohydride, thus allowing its
reuse.

28
30. A battery as in claim 26 wherein the catholyte
comprises of oxidizing agents that can be oxidized by air in
basic solution.

- 1 ²⁹~~31~~. A battery as in claim ²⁸~~30~~ wherein the catholyte
2 contains iodate (IO_3) and I^- .
- 1 ³⁰~~32~~. A battery as in claim ²⁸~~30~~ in which the catholyte
2 contains ferricyanide and ferrocyanide.
- 1 ³¹~~33~~. A battery as in claim ²⁸~~30~~ in which the catholyte
2 contains chromate and Cr^{+3} .
- 1 ³²~~34~~. A battery as in claim ²⁸~~30~~ in which the catholyte
2 contains manganese at valence +2 and +3.
- 1 ³³~~35~~. A battery claim ²⁸~~30~~ in which the catholyte
2 contains tin at valence +2 and +4.
- 1 ³⁴~~36~~. A battery as in claim ²⁸~~30~~ in which the catholyte
2 contains Cobalt at valence +2 and +3.
- 1 ³⁵~~37~~. A battery as in claim ²⁸~~30~~ in which the catholyte
2 comprises a catalyst to aid the reoxidation of the oxidation
3 agent to the higher oxidation state by air.
- 1 ³⁶~~38~~. A battery as in claim ²⁶~~28~~ comprising a chamber
2 separate from the cathode compartment in which reoxidation
3 of the catholyte takes place.
- 1 ³⁷~~39~~. A battery as in any one of claims ²⁶⁻³⁶~~28-38~~
2 comprising two units, one that is the direct air breather,
3 and another unit which comprises a catholyte which can be
4 oxidized by air and can then oxidize borohydride to borate
5 with the generation of electrical current.

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40. A battery as in claim 11 or claim 26 which
PW 1 contains a bi polar electrode.
2

39
41. A battery as in claim 11 or claim 26, further
1 comprising external storage tanks for storage of anolyte,
2 catholyte or both anolyte and catholyte.
3

42. A battery of claim 12 or claim 28 comprising a
1 cell to generate electricity by oxidation of the reduced
2 compounds which is physically separated from a second cell
3 for generating the reduced compound from the oxidized
4 compound.
5

43. A battery as in claim 12 or claim 28 comprising
1 a cell which is used both to generate electricity from the
2 oxidation of the reduced compound and to generate the
3 reduced compound from the oxidized compound.
4

42
44. A battery as in claim 11 or claim 26 comprising
1 a controller connected to at least one source of a reactant,
2 the controller determining the transport of the reactant to
3 the anode or the cathode, the battery further comprising a
4 monitor to determine a battery characteristic and to produce
5 a signal to the controller in response to monitored values
6 of the characteristic.
7

43
45. A battery as in claim 42 where the monitor
1 comprises at least one probe which generates an input signal
2 responsive to a characteristic selected from the group consisting of
3 conductivity, voltage, current and power output, ion
4 concentration, pH, index of refraction, colorimetric, COD,
5 turbidity, ^{and} density, the input signal being transmitted to
6 an electronic processor, the processor being connected to
7

8 the controller which controls flow into a battery
9 compartment.

1 ⁴⁴~~46~~. A battery as in claim ¹¹~~12~~ or claim ²⁴~~28~~ which
2 comprises an electrode comprising a conductive substrate
3 which is coated.

1 ⁴⁶~~47~~. A battery as in claim ¹¹~~12~~ or claim ²⁴~~28~~ which
2 comprises an electrode, the electrode comprising a substance
3 selected from the group consisting of: a) an alloy of
4 bismuth, thallium, cadmium, tin, lead, gallium, or indium;
5 b) mercury, mercury amalgamated with other metals, or
6 mercury coated on a conductive substrate; c) tellurium or
7 tellurides.

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1 ~~48. A battery as in claim 12 or claim 28, which~~
2 ~~comprises an electrode, the electrode comprising a material~~
3 ~~to enhance electrode properties such as corrosion~~
4 ~~resistance.~~

1 49. A battery as in claim 47 in which the electrode
2 further comprises a material to enhance electrode properties
3 such as corrosion resistance.

1 50. The battery of claim 47 in which the electrode
2 is a bipolar electrode comprising two sides, one of the
3 sides being coated with said substance, and a second side
4 being coated with a material of low oxygen overvoltage such
5 as gold, or iridium oxide.

1 ⁴⁹~~51~~. A battery as in claim ⁴⁵~~47~~ in which the electrode
2 is a bipolar electrode having two sides, one of the sides

3 being coated with said substance, and a second side having
4 an air breathing electrode.

1 ⁵⁰ 52. A battery as in claim ³⁸ 40 in which the bi polar
2 electrode comprises a sheet of conductive material.

1 ⁹¹ 53. A battery as in claim ⁵⁰ 52 in which the
2 conductive material is stainless steel or gold plated
3 copper.

1 54. A battery as in claim 12 comprising an
2 electrode having a smooth or high surface area of foam metal
3 or tubes, cylinder, fibers, or other geometric shape,
4 powder, coated or uncoated catalyzed or uncatalyzed.

1 55. A battery as in claim 12 configured as a sealed
2 unit of physical size and shape and correct voltage range to
3 meet form fit and function specifications of a standard
4 battery for a consumer electronic or electrical device.

1 56. A battery as in claim 55 in which the standard
2 battery is: a button for a hearing aid; AAA; AA; A; B; C; D;
3 9 volt; a computer battery; a cellular phone battery.

1 ⁵⁵ 57. A battery as in claim ¹¹ 12 characterized by
2 voltage and current production suitable for ignition and
3 starter motor operation in a vehicle powered by an internal
4 combustion engine.

1 ⁵⁴ 58. A battery as in claim ¹¹ 12 or ²⁶ 28 in which at
2 least one of the cells is configured to be suitable for
3 installation on a vehicle that uses electricity either
4 partially or entirely to propel the vehicle.

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1 59. A battery as in claim 39 in which at least one
2 of the cells is configured to be suitable for installation
3 on a vehicle that uses electricity either partially or
4 entirely to propel the vehicle.

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1 60. A battery as in claim 12 or 28 configured to be
2 suitable for storage of electricity for applications such as
3 electric utility load leveling and other means of storage of
4 electricity.

1 61. A battery as in claim 39 configured to be
2 suitable for storage of electricity for applications such as
3 electric utility load leveling and other means of storage of
4 electricity.

1 62. A method of generating a current over time
2 comprising,
3 providing the battery of claim 12 and connecting it
4 to a load.

1 63. The method of claim 62 further comprising the
2 step of generating an electrical current by oxidation of
3 borohydride anion to borate anion, and recharging the
4 battery by applying an electrical potential to the anode to
5 regenerate borohydride anion from borate anion.

1 64. The method of claim 62 further comprising the
2 step of generating an electrical current by oxidation of
3 borohydride anion to borate anion, and then replacing
4 discharged anolyte with anolyte comprising borohydride anion
5 suitable for oxidation to borate anion.

1 65. A method of synthesizing a borane ion by
2 electrical reduction of borate ion.

1 66. A method according to claim 65 in which the
2 borane ion is borohydride.

1 67. A method according to claim 65 or 66 in which
2 the method recharges a battery.

1 68. A method as in claim 65 comprising monitoring
2 the synthesis using of a probe which generates an electrical
3 signal representative of a characteristic selected from ORP,
4 conductivity, voltage, current and power input, ion
5 concentration, pH, index of refraction, colorimetric, COD,
6 turbidity, density, said signal being transmitted to an
7 electronic processor, the processor being connected to the
8 controller which controls flow into a cell compartment which
9 is connected to a regulate flow into each compartment.

1 69. A method according to claim 66 in which the
2 borate and borohydride ion are in an aqueous carrier.

1 70. A method as in claim 69 in which the electrical
2 reduction of borate takes place in a cell having as a
3 cathode an electrode of high hydrogen overpotential.

1 71. An method as in claim 70 in which the reduction
2 of borate ions is accomplished by applying a potential to an
3 electrode comprising: a) an alloy of bismuth, thallium,
4 cadmium, tin, lead, gallium and indium; b) mercury or
5 mercury amalgamated with other metals or mercury coated on a
6 conductive substrate or c) tellurium or tellurides to

7 further inhibit the release of hydrogen gas while current is
8 passed through.

1 72. A method in claim 65 or claim 71 in which the
2 reduction of borate ions is accomplished by applying a
3 potential to an electrode comprising an additive to enhance
4 corrosion resistance or other electrode properties.

1 73. The method as in claim 70 which further
2 comprises recovering a reduced species in addition to
3 borohydride, the reduced species comprising a metal or a
4 compound from an aqueous and/or non aqueous systems.

1 74. A method of claim 70 in which the cell contains
2 a bi-polar electrode.

1 75. A method according to claim 65 or claim 66
2 which is performed in a cell containing a permiselective
3 membrane.

1 76. The method of claim 75 in which the
2 permiselective membrane is an anionic membrane, a cationic
3 membrane, or a bipolar membrane.

1 77. A method as in claim 65 or claim 66 which
2 comprises releasing oxygen from an anode while producing
3 borohydride in a catholyte.

1 78. A method as in claim 65 or claim 66 which
2 comprises producing an oxidized species as a product in an
3 anode chamber.

1 79. A method as in claim 65 or claim 66 which is
2 performed in an aqueous medium.

1 80. The method of claim 65 wherein the borane is
2 not borohydride, and the method comprising adding partial
3 reduction adducts or other adducts to the catholyte.

1 81. The method of claim 80 in which the adducts are
2 selected from the group consisting of cyanide ion, amide
3 ion, halide ions, and pseudohalides.

1 82. A method as in claim 65 or claim 66 which is
2 performed in a non aqueous medium.

1 83. A system of transporting a borohydride anion
2 from a generation point to a consumption point, by applying
3 an electrical potential to a solution of oxidized
4 borohydride at the generation point to produce borohydride
5 in a first cell and transporting the resulting borohydride
6 solution to the consumption point where the borohydride is
7 provided for oxidization in a second cell.

1 84. A system as in claim 83 further comprising
2 transporting spent solution comprising oxidized borohydride
3 from a consumption point to the generation site and applying
4 the electrical potential to the spent solution at the
5 generation point to produce borohydride in the first cell.

1 85. A system such as in claims 83 or 84 wherein the
2 oxidized borohydride solution is transported back to the
3 generation point to be reused for generation of borohydride.

1 86. A system as in any one of claims 83 or 84 in
2 which at least one of the cells is configured to be suitable
3 for installation on a vehicle that uses electricity either
4 partially or entirely to propel the vehicle.

1 87. A system as in any one of claims 83 or 84
2 configured to be suitable for storage of electricity for
3 applications such as electric utility load leveling and
4 other means of storage of electricity.

1 88. A system as in claim 83 further comprising a
2 step in which the borohydride is combined with water to
3 generate hydrogen by reduction of water.

1 89. A system as in claim 88 in which the
2 generation of hydrogen is catalyzed by the presence of
3 transition metal compounds.

1 90. The system of claim 89 in which the generation
2 of hydrogen is catalyzed by a cobalt (II) compound.

1 91. The system of claim 90 in which the cobalt(II)
2 compound is cobalt(II)hydroxide.

1 92. The system of claim 88 further comprising a
2 step of transporting the generated hydrogen to a consumer.

1 93. A system of transporting borohydride as a
2 method of transporting energy to a given location.

1 94. A system of transporting and distributing
2 borohydride such that vehicles that operate with borohydride

3 may fill up with fresh borohydride and discharge the
4 borates.

1 95. A system such as in claim 94 where the borate
2 solution is converted to borohydride solution with a cell
3 for synthesizing borohydride ion and/or recharging a battery
4 by electrical reduction of borate ion.

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